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(54) Title: SHAPED BODY MADE OF IMPREGNATED WOOD			
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(57) Abstract			
<p>The invention concerns a shaped body made of wood which is impregnated with a biodegradable polymer and/or solid natural resin or drying (setting) oil. Wax, fats, salts and/or flame-retardants can also be added to the impregnating agent. The shaped body is pre-heated to a temperature of between 100 and 150 °C, optionally placed under vacuum, and immersed in a melt of the impregnating composition. The shaped body remains in this melt - preferably at an excess pressure of between 3 and 20 bar, in particular between 8 and 12 bar - for between 15 and 120 minutes, preferably for between 30 and 90 minutes. The shaped body is then removed from the melt and any remaining melt is eliminated from the surface of the shaped body which is finally cooled.</p>			
(57) Zusammenfassung			
<p>Ein Holz-Formkörper wird mit einem biologisch abbaubaren Polymer und/oder festem Naturharz, bzw. trocknendem (härtendem) Öl imprägniert. Dem Imprägnierungsmittel können auch Wachse, Fette, Salze und/oder Flammschutzmittel zugesetzt sein. Der Formkörper wird auf eine Temperatur von 100-150 °C vorgewärmt, gegebenenfalls unter Vakuum gesetzt und in die aus der Imprägnierungszusammensetzung gebildete Schmelze eingetaucht. Dort verbleibt er - vorzugsweise unter einem Überdruck von 3-20, insbesondere 8-12 bar - 15-120, vorzugsweise 30-90 Minuten lang, wird anschliessend aus der Schmelze entfernt, von ihr oberflächlich befreit und ausgekühlt.</p>			

Shaped Body Made of Impregnated Wood

The invention relates to a shaped body made of impregnated solid wood. Since ancient times, wood has been impregnated with various substances, mainly as protection against fungi and insects, for reducing the water absorption or improving the swelling behaviour, for example with tar oil (for wood plaster), paraffin and waxes, or with mixtures of montan wax and synthetic resin solutions (alkyd resins), but the problem of removing the solvent (eg. trichloroethylene) from the impregnated solid wood persists. For the production of bearing discs, wood was also impregnated with lubricating oil.

This is better achieved, in particular for dimensional stabilisation and an increase in the hardness, with water-soluble phenol/formaldehyde or urea/formaldehyde resins; however, these generally only delay but do not suppress the swelling and on the other hand result in a reduction in the tensile strength. They are therefore used as a rule only in the case of veneers, which are then optionally further processed as moulded laminated materials. In addition, the combination of wood with urea/formaldehyde resin, as well as with other plastics, leads to thermosetting materials which, after shaping and subsequent crosslinking, can no longer be thermoplastically shaped, and are no longer biodegradable and can therefore present a disposal problem.

The impregnation of veneers with dye and polyethylene glycol or polypropylene glycol and with an aqueous solution of starch, polyvinylpyrrolidone or polyvinyl acetate for the production of coloured laminates produced by bonding together individual veneers (JP-A54-117004 or JP-A55-034931) as well as the impregnation of only the cut edge of wood before the veneer peeling process for edge strengthening, once again with aqueous solutions of starch, gelatin, polyvinyl acetate, sodium alginate, polyvinylpyrrolidone, resol, melamine or urea resin, monomers, such as acrylic or methacrylic esters, styrene, vinyl acetate, acrylamide or acrylonitrile, etc. (JP-A54-02 6317), has also been disclosed.

Finally, the impregnation of wood or porous mineral materials with an aqueous polyvinyl acetate solution in vacuo and subsequent application of slightly super atmospheric pressure has also been disclosed, optionally wax and/or biocides being added (FR-A2505187).

Other publications, too, are concerned with the impregnation of wood parts with nonbiodegradable, polymerisable or crosslinking synthetic resins or linseed oil, frequently from solutions, with the stated disadvantages; these include in particular DE-A1-3942136, FR-A-2647388, JP-A-6071614, JP-54 057 732, WO94/11167, US-A-1991752, SU-A1-1701521, JP-A-1174401, SU-A-1288063 and NL-A-23392.

However, all these methods for the production of impregnated shaped wood bodies have the disadvantage that the removal of the solvents used (including water) on the one hand is time-consuming and energy consumptive and on the other hand leaves behind a shaped body which is porous - even if to a lesser extent than previously.

It is therefore the object of the invention to provide an impregnated, biodegradable shaped solid wood body whose pores are very substantially filled but which is relatively light and can be produced without special finishing, and overcomes the disadvantages of the conventional combinations of wood and plastics with respect to porosity, biodegradability and thermoplasticity. This object is surprisingly achieved for the first time, according to the invention, by a shaped body comprising impregnated solid



wood, characterised in that it was impregnated with at least one essentially solvent-free and thermoplastic substance or mixture which is or contains a biodegradable polymer, a natural resin and/or an ester of higher fatty acids with polyhydric alcohols, and which is solid up to 50°C but liquid above about 80°C and has a viscosity of less than 20dPas, expediently less than 10dPas, in particular less than 1dPas, at a temperature between about 115 and about 155°C. In the shaped body according to the invention, it is preferred that the biodegradable polymer originates from the group consisting of the following substances: polyhydroxybutyric acids, polycaprolactones, polylactic acids, polyesters based on diols and dicarboxylic acids, polyamides, polyesterurethanes; chemically modified, natural polymers, such as, for example, cellulose acetates; that the natural resin originates from the group consisting of the following substances: tall resin, dammar, copal and balsam resin; and that the fatty ester originates from the working up of tall oil to give tall resin. It is preferred that the impregnating agent furthermore contains a drying or semidrying (setting) oil, in particular blown (preoxidised) linseed oil or wood oil, optionally with the addition of a drying agent or at least one of the following substances: waxes, in particular Camauba wax, bees' wax, montan wax; lignin, higher alcohols; hardened or modified, animal and vegetable fats, for example hydrogenated vegetable fats and epoxidised oils; wool fat, tallow; salts of different fatty acids, such as, for example, stearic acid, behenic acid, lauric acid; flame retardants - the latter optionally with the addition of small amounts of a solubiliser, such as, for example, glycerol. In a preferred embodiment of the invention, the impregnating composition consists of

- 20 - 10- about 60% by weight of natural resin;
- 10-40, preferably 15-35% by weight of wax;
- 10-50, preferably 20-40% by weight of drying oil;
- 0.25-20% by weight of drying agent, in particular cobalt, zinc and manganese resinsates, octanoates, linoleates and naphthenates; and
- 25 - 10-30, preferably 15-25% by weight of a biodegradable polymer.

The natural resin used is in particular a monomer from the group consisting of tall resin, dammar, copal; but also balsam resin or tall oil; as oil, in particular blown (preoxidised) linseed oil or wood oil, optionally with the addition of a drying agent (siccative); as fatty ester, in particular one which is obtained when tall oil is worked up to give tall resin.



For the purposes of the invention, the polymers, natural resins, oils or fatty esters chosen should be in particular those which are liquid at the loading temperature and preferably do not attack the wood. Substances which have a relatively low viscosity below the temperature at which the wood is attacked are particularly preferred. A person skilled in the art will choose a mixture of impregnating agents and any additives such that a solid wood part to be impregnated reaches the desired degree of penetration within an appropriate time depending on its porosity optionally with the use of a vacuum and/or pressure. For the purposes of the invention, "attack" is to be understood as meaning any undesired change in the properties, in particular discolouration; decomposition by chemical reaction, in particular in the case of extreme changes in the pH; swelling or shrinkage (where undesired); pore formation, etc. It is self-evident that some thermoplastic materials according to the invention may be suitable for impregnating specific wood types but not for others. For example, slight discolourations may still be acceptable in the case of darker woods; certain woods may be more insensitive than others to certain pH changes, etc.

In recent years, as a result of the discussion of the environment, a quantity of various biodegradable materials based on natural substances, including fossil sources, have been developed, among which many even exhibit hydrophilic character and, like many natural substances and in particular wood are capable of absorbing and releasing water. These materials contain certain percentages of water, depending on the relative ambient humidity, and are therefore more suitable for combination than plastic in the conventional sense. Their hydrophilic character also facilitates the penetration into the wood matrix, the properties of wood not being completely masked but merely supplemented.

The following substances may be mentioned as examples of biodegradable polymers: polyhydroxybutyric acids, polycaprolactones, polylactic acids, polyesters based on diols and dicarboxylic acids, polyamides, polyesterurethanes, chemically modified natural polymers, such as, for example, cellulose acetates.

Further additives, for example various fats, oils, waxes, as well as lignin or alcohols, in particular to the natural resins, oils or fatty esters are used for producing specific properties in the completely impregnated shaped solid wood bodies, without substantially limiting the thermoplasticity or biodegradability. In particular, hardened or modified, animal and vegetable fats, for example hydrogenated vegetable fats, epoxidised oils, wool fat, tallow as well as salts of various fatty acids, such as, for example, stearic acid, behenic acid, lauric acid, etc., may also be used.

Finally, various salts, such as, for example, phosphates, borates, sulphates, chlorides and silicates, may also be concomitantly used by introducing them with the melt into the wood structure. They have a positive effect on the reduction of the swelling and shrinkage behaviour, but also have flame-retardant and/or fungicidal activity.

Glycerol, too, is used as a "solvent" plasticiser or humectant; alkali metal and alkaline earth metal resins act as drying agent, but also as wetting agents and emulsifiers and thus promote the penetration of the resins into the wood.

Some of the resins are preferably used in combination with wax and/or a drying oil, which are to become hard or solid and even brittle at room temperature but soften at higher temperatures and then



preferably have a significant viscosity gradient so that leading can still take place at temperatures at which wood is not attacked at all or is only slightly attacked. The brittleness of some of the stated substances is compensated by the fine distribution in the wood matrix.

The viscosity of the impregnating composition at the leading temperature should be less than 20dPas, expediently less than 10dPas (the viscosity of glycerol at room temperature), in particular less than 1dPas (water has 0.01dPas at room temperature) while the pores in solid wood are of the order of magnitude of a few μm , the resins or polymers according to the invention have a size of a few nm. The smaller the molecules, the more rapidly and more deeply do they penetrate into the wood. The largest in particular polymeric particles will penetrate only into the uppermost layers of the surface at the respective treatment temperature in the respective treatment time; however, it is exactly this which gives rise to the advantage that the surface properties of the shaped body according to the invention in particular with regard to hardness and visual appearance (eg. polishability) are improved without impairing the thermoplastic mouldability. Moreover, the diffusion of the smaller molecules from the interior at elevated temperature is effectively prevented.

Preferably used waxes are natural ones, such as, for example, Carnauba wax, bees' wax or montan wax. Waxes have even more advantageous processing conditions, such as a generally lower melting point and an even sharper viscosity gradient with increasing temperature. The combination of wax and resin exhibits good processing properties and end product properties since the unpleasant property of economical balsam resin, ie. being tacky at room temperature is compensated by the use of waxes. On the other hand, waxes alone tend to sweat at slightly elevated temperatures of use, which in turn is suppressed by the natural resins present in the mixture.

Linseed oil and wood oil are liquid even at room temperature prior to "drying" (curing by polymerisation), the viscosity decreasing further with increasing temperature. A linseed oil having a viscosity of 90dPas at room temperature exhibits a viscosity drop to 15dPas when the temperature is increased by only 30°C. This low viscosity in combination with the small molecular size since it is also initially a monomer considerably supports the impregnation process. The combination of such an oil with resin permits the production of virtually linoleum-like shaped bodies in a natural wood matrix.

For the catalytic acceleration of the polymerisation reaction (drying) of the oils used, so called metal soaps based on one or more metals (in combination), in particular cobalt, zinc and manganese resinsates, octanoates, linoleates and naphthenates, are used as drying agents.

What was surprising in the case of the combination of biodegradable thermoplastics, some of them hydrophilic, and wood, a hydrophilic thermosetting plastic, was that it leads to products, shaped articles or materials in which the characteristic properties of wood, in particular with regard to the water absorption and release, biodegradability and mechanical properties, which are known to be excellent, are not lost. The wood additionally acquired the properties of thermoplasticity, improved surface and, in specific cases, faster biodegradability; completely novel fields of use have thus been opened up for such shaped articles.

The swelling and shrinkage of wood is a property which substantially limits its use in many cases, and is reduced by at least 50% by the process according to the invention. Consequently, the



expensive measures during processing, for example repeated gluing, tongue-and-groove joints and provision of expansion joints, are reduced.

The higher the temperatures chosen for impregnation of the solid wood parts, the better the vacuum which can be applied before the impregnation or the higher the air, gas or steam pressure which can be applied during or after the impregnation, the faster and more complete is the penetration of the thermoplastic materials into the wood matrix.

For the production of the shaped bodies, various types of wood may be used, whether hard or soft wood or very thin-walled or thick wood parts are employed depends predominantly on the requirements of the end products. For example, eucalyptus and poplar wood, as fast-growing plantation timbers, are used predominantly for pulp production or as energy sources. Their rapid growth results in only a low total hardness and surface hardness. As a result of the treatment according to the invention, these woods can however also be used for high-quality applications, for example in the floor and window sector, and therefore replace more expensive high-quality natural timbers which are in increasingly short supply.

15 A good example of the improvement of the durability of wood is also the beech, which can be easily laden with the melts described and achieves a substantial improvement in durability, stability and also resistance to microorganisms.

Wood is by nature only very slightly thermoplastic. The shaped bodies according to the invention on the other hand can be subjected to conventional techniques of thermoplastic forming, 20 such as embossing, pressing, bending and shaping, just as easily as the conventional plastics parts. This thermoplastic forming takes place substantially without destruction of the material wood structure, so that in certain cases the wood grain is even completely retained.

The properties of the shaped solid wood bodies according to the invention can be varied within wide limits by the choice of the type and amount of material and any additives and of the process 25 parameters, such as temperature and pressure. Said properties include, for example, the rate of biodegradation, which can even be slowed down compared with wood by the use of slowly degradable substances, such as, for example, cellulose acetate. However, the density of the shaped articles, too, can be changed within a wide range. This ranges from very low loading of light wood (density 0.2t/m^3) to a fully laden wood matrix with about 1.5t/m^3 . A frequently desired effect, especially 30 in the case of soft wood parts, is the dramatic increase in the surface hardness by the incorporation of a material according to the invention into the wood matrix, so that, by their very nature, soft woods are also suitable for high-quality floors.

To counteract the disadvantage of the easy flammability of the wood parts laden with resins, waxes and possibly oils, flame retardants, such as, for example, ammonia phosphate and zinc borate, 35 may be added to the leading melt, it being possible to use glycerol as a solubiliser.

A possible procedure would be complete immersion of the wood part preferably evacuated beforehand into the molten material and immediate application of super atmospheric pressure, which leads substantially more rapidly to the desired result of complete and uniform distribution of the thermoplastic material in the wood matrix. A further improvement of the impregnation process can be



achieved by predrying the shaped solid wood bodies, with the result that the liquid material is sucked even into relatively deep wood layers previously occupied by water molecules.

The shaped pieces thus obtained can be processed in the same way as wood and have the additional property of thermoplastic mouldability, although they can still be readily disposed of through biodegradability.

A wide field of use is open for the finished, possibly thermoplastically processible parts. Any number of further examples can be added to the fields of use such as packaging, furniture construction, flooring, vehicle construction and wood construction, interior finishing and toys.

Example 1:

A 120mm long, 80mm wide and 20mm thick soft wood panel having a density of 420kg/m³ is heated to 120°C and immersed in a molten low molecular weight polycaprolactone from Union Carbide, at 150°C; a vacuum is applied for 15min. The panel is then removed from the melt and exposed to a gas pressure of 10bar in a pressure chamber for 30min to allow the polymeric, biodegradable material to penetrate into deeper wood layers. The panel can be permanently deformed at 170°C, steam having a supporting effect.

Example 2:

Tall resin (Sacatan® 85 from Krems Chemie, softening temperature 80-85°C) is melted in an open vessel and brought to a temperature of 155°C. Wood parts 250mm long, 80mm wide and 15mm thick are introduced into this hot resin melt. This introduction is effected in a perforated basket which separates the individual pieces of wood from one another so that the total surface of each wood part is surrounded by liquid resin, the wood parts are kept below the liquid level and removal from the hot resin melt is possible.

After the introduction of the pieces of wood, heating of the wood parts causes the moisture contained to evaporate and the air contained to escape. This process lasts for about 15 minutes, while the temperature of the resin solution is kept at 150°C. The vessel is then closed and a gas pressure of 9bar is applied, which is intended to introduce the resin into deep wood layers. After pressure has been applied for 1 hour, it is relieved and the laden pieces of wood are removed from the still liquid resin (125°C). The amount of resin absorbed during this treatment can be determined by differential weighing:

Wood type	Weight before loading in gram	weight after loading in gram	% of resin, based on total weight	% of resin, based on the weight of wood
Ash	136	198	31	46
Birch	259	400	35	54
Oak	152	169	10	11
Pine	266	466	42	75
Spruce	99	119	17	20
Alder	188	368	49	96
Lime	113	158	28	39
Beech	139	210	34	51
Fir	284	293	3	3
Larch	196	201	2	2
Maple	284	436	34	53
Cherry	361	411	12	14



The resin had become homogeneously distributed in the wood matrix. The wood could be readily subjected to the classical woodworking methods. The colour changes due to thermal stress and resin introduction (change of light scattering due to filling of wood cavities) on the wood differ according to wood type but are detectable in every type of wood. The finally laden wood part (planed) is still rated as slightly tacky. When the wood which was dry but still contained about 10% of residual moisture was introduced into the resin melt, a certain degree of foaming, caused by evaporation of the residual water and expulsion of the excess air, was observed, said foaming being not dissimilar to a "frying process" in the food industry. This behaviour can be reduced or completely eliminated if reduced pressure is applied in the treatment vessel and/or the wood parts are preheated preferably before immersion of the wood parts in the resin melt.

Example 3:

While retaining the essential experimental conditions according to Example 2, the wood used was merely preheated to 150°C before being introduced into the resin melt. On the one hand, this results in predrying of the wood and, on the other hand, the air contained in the wood has escaped according to the temperature. The wood pretreated in this manner showed only very little or no foaming, and the pressure vessel could be closed immediately after introduction of the wood. The fear that this drying process might reduce the amount of resin loaded was not confirmed. The loading amounts found were virtually identical to those according to Example 2.

Example 4:

To minimise the discolouration of the wood by the thermal stress, a balsam resin was used, which begins to soften at 60-65°C and has a low viscosity at 115°C. The wood was pretreated for one hour at 115°C and was introduced into the resin melt at the same temperature. A very short leading time of only 15min, but at a pressure of 15 bar, substantially reduced the discolouration of the wood. The amount of resin loaded corresponded substantially to the data of Example 2. However, what was rather unpleasant was the fact that the resin-laden wood parts are slightly tacky even at room temperature, which is probably associated with the low melting point of the balsam resin.

Example 5:

As a negative example from the prior art, the wood parts described in Example 1 were laden under conditions similar to those in Example 1, but only with Camauba wax or with a montan wax (melting point: 75°C) from Schlickum. The melting point was 155°C; the wood was predried for 60 minutes at 130°C; the temperature when the wood was removed was 120°C. The amount of wax absorbed corresponds approximately to that which had been found in the case of resin. During heating tests on the wax-laden pieces of wood, however, an unpleasantly rapid release of the liquid wax from the wood matrix was observed from about 80°C.

Example 6:

To minimise the remaining disadvantages of the pure wax or pure resin impregnation of the wood, the two materials were combined with one another. Surprisingly, waxes and resins can be combined with one another without limits; they form a common, clear melt which has a common softening point. They can no longer be separated from one another even by cooling.



66% of tall resin (Sacetan® 85) and 34% of montan wax (Isclablend® 207 from Schlickum) were melted together and gave a softening temperature of about 80°C. The further condition for loading wood with this combination corresponded to the conditions mentioned in the preceding Examples. The amount loaded was comparable with the values stated in the Table of Example 2.

The laden pieces of wood thus obtained combined the positive properties of the variants laden only with resin or only with wax. The tacky impression of wood laden only with resin was sufficiently reduced by the use of wax; on the other hand, the release of melt from pure wax-laden pieces of wood on increasing the temperature is decisively reduced.

Wood type	Brinell hardness before loading	Brinell hardness after loading	Reduction of swelling and shrinkage in %
	parallel to the fibres		
Ash	60	90	50
Pine	40	70	40
Alder	30	75	60
Beech	70	95	70
Spruce	30	55	30

Example 7:

However, the disadvantage of thermoplastic materials whereby they emerge again in relatively large amounts from the wood when softening temperatures are exceeded can also be counteracted with the aid of drying oils. These are still present as monomers at the beginning of the process and accordingly diffuse readily into the wood matrix. They are then oxidised by the atmospheric oxygen, and the softening on an increase of temperature is accordingly prevented.

A wood part was preheated at 130°C for 60min and introduced into a blown (preoxidised) linseed oil ("90 P" from Lechner and Crebert) preheated to 140°C. The other experimental conditions corresponded to Example 2. The wood was removed at 115°C. The following loading amounts were determined by differential measurement:

Wood type	weight before loading in gram	Weight after loading in gram	% of oil, based on total weight	% of oil, based on the weight of wood
Ash	127	187	32	47
Birch	258	382	32	48
Oak	135	140	4	4
Pine	175	305	43	74
Spruce	110	123	11	12
Alder	183	338	46	85
Lime	110	164	33	49
Fir	153	218	30	42
Larch	206	214	4	4
Maple	279	411	32	47

The wood parts were exposed to the air for a few weeks at room temperature so that superficial oxidation of the linseed oil could take place and the wood parts no longer felt tacky.

Example 8:

To accelerate the incomplete long-lasting oxidation of the linseed oil, resins or metal salts of different resin acids and other drying agents are used for improving the hardness properties. The raw material composition of the biodegradable material mixture was 70% of linseed oil, 14% of zinc



resinate, 15% of rosin and 1% of cobalt octanoate. Said composition was heated to 150°C until a clear solution was obtained. The further working conditions for leading the wood corresponded to the preceding experiments.

The aim of this raw material mixture was to enable the raw materials, which are used for linoleum production, to penetrate the wood matrix while still in liquid form or as thermoplastic substances and hence to combine the properties of wood and linoleum with one another or, so to speak, to enable the linoleum to form in the wood.

Example 9:

A raw material mixture consisting of 30% of linseed oil, 15% of zinc resinate, 15% of rosin, 20% of Carnuba wax and 19% of biodegradable polyester (Skygreen®) and about 0.5% of manganese resinate is heated to 150°C so that a clear but coloured solution forms. The other loading conditions correspond to Example 2. The raw material combination gave end products having the following properties:

- Continuous further drying of the linseed oil even when the wood surface is damaged.
- The resin and wax content improves the hardness of the wood.
- The wax content reduces the tack at the linseed oil and at the resin.
- Owing to its macromolecular structure, the polyester remains predominantly at the surface of the wood.

The pieces of wood are tested with respect to their Brinell hardness, perpendicular to the fibre direction, in accordance with DIN EN 10003-1, and with respect to their flexural strength in accordance with DIN 52186:

	Brinell hardness	Flexural strength		
	N/mm ²	Increase %	N/mm ²	Increase %
Pine before	6.5		118	
Pine after	11.1	69.5	137	15.4
Alder before	11.9		104	
Alder after	32.4	171.0	143	37.7
Beech before	22.8		162	
Beech after	42.2	84.7	179	10.8
Ash before	23.9		149	
Ash after	38.1	59.4	159	7.0

The laden wood pieces were introduced into a press which contained embossing plates already preheated to 140°C. The press was slowly closed and was kept at a moulding pressure of 50bar for 2min. The parts shaped in this manner had a wattle pattern embossed 2 mm deep, with intact, closed surface and undamaged edges. Pieces of wood thermoplastically moulded in this manner can be used, for example, as stair covering.

Example 10:

In order further to improve the penetration of the polyester and to ensure the possibility at loading of relatively long pieces of wood too, the surface at the wood parts of this Example was perforated with very fine needles to a depth at about 3mm before their introduction into the molten raw materials. The treatment conditions, as well as the raw material composition, corresponded to the preceding Example. The depth of penetration of relatively high molecular weight, thermoplastic



materials too, can be accurately controlled by a very fine perforation. The perforation can be made in such a way that no surface damage is visible macroscopically. With this possibility, the "wood loading" can also be carried out for substantially larger wood dimensions and for timbers which by their very nature are poorly loadable.

Example 11:

If it is wished to load solid wood completely with thermoplastic materials, the solid parts are evacuated prior to loading; without eliminating the vacuum, the procedure is effected as in Example 9 by introducing the melt described there in the evacuated loading vessel. A loading pressure of 9bar is then maintained for 1h at 150°C, with the result that the melt is particularly uniformly distributed even in the interior of the shaped body.

Example 12:

If it is wished not to load solid wood quantitatively but only to modify the cell walls in order to influence in particular the swelling and shrinkage behaviour but not substantially to change the hardness, the following procedure is adopted:

The conditions and the raw material mixture correspond to Example 8. The still untreated wood introduced into the loading vessel was exposed to an air pressure of 4bar for 15min before introduction of the molten material and the procedure is then continued without pressure reduction as in Example 8. The impregnation pressure is set at 15bar and is maintained for 100min. As a result of the "prestressing" of the wood parts under pressure, after the pressure has been let down the liquid raw material components, too, are forced out by the escape of the compressed air, and filling of the wood cavities is thus prevented. Only the cell walls are laden with the substances. Subsequent plastic forming of the solid wood parts can thus be carried out more easily, particularly when only the surface is to be further shaped by embossing, i.e. by displacement or compaction of specific parts.

Example 13:

The combination of natural resin, wax and a biodegradable polyester, for example in the form of a polylactide, is also particularly preferred. The loading melt consists of 65% of Erkazit 415 (from Kraemer), 25% of IscoBlend 231 (from Schlickum) and 10% of ECOPLA (from Cargill). The loading conditions correspond to the preceding Examples. The polylactide is deposited as a cohesive coating over the wood surface with only a small (2mm) depth of penetration.

Example 14:

The so-called fixing of the "swollen" wood structure by the displacement of the water and simultaneous incorporation of thermoplastic materials in the cell structure of the wood results in substantially reduced swelling and shrinkage behaviour.

The following behaviour is chosen for achieving this:

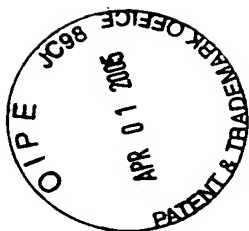
Before introduction into the melt, the wood parts are conditioned in such a way that the so-called fibre saturation point (water content between 12 and 20% by weight of water, depending on the type of wood) is reached. The melt composition corresponds to Example 9. The melt temperature is 140 degrees Celsius. The wood parts are introduced rapidly into the melt, without preheating. The



The claims defining the invention are as follows:

1. Shaped body comprising impregnated solid wood, characterised in that it was impregnated with at least one essentially solvent-free and thermoplastic substance or mixture which is or contains a biodegradable polymer, a natural resin and/or an ester of higher fatty acids with polyhydric alcohols, and which is solid up to 50°C but liquid above about 80°C and has a viscosity of less than 20dPas, at a temperature between about 115 and about 155°C.
2. Shaped body according to claim 1, characterised in that the at least one essentially solvent-free and thermoplastic substance or mixture has a viscosity of less than 10dPas.
3. Shaped body according to claim 1, characterised in that the at least one essentially solvent-free and thermoplastic substance or mixture has a viscosity of less than 1dPas.
4. Shaped body according to any one of the preceding claims, characterised in that the biodegradable polymer originates from the group consisting of the following substances: polyhydroxybutyric acids, polycaprolactones, polylactic acids, polyesters based on diols and dicarboxylic acids, polyamides, polyesterurethanes; chemically modified, natural polymers.
5. Shaped body according to claim 4, characterised in that the biodegradable polymer originates from cellulose acetates.
6. Shaped body according to any one of the preceding claims, characterised in that the natural resin originates from the group consisting of the following substances: tall resin, dammar, copal and balsam resin.
7. Shaped body according to any one of the preceding claims, characterised in that the fatty ester originates from the working up of tall oil to give tall resin.
8. Shaped body according to any one of the preceding claims, characterised in that the impregnating agent furthermore contains a drying or semidrying (setting) oil optionally with the addition of a drying agent.
9. Shaped body according to claim 8, characterised in that the drying or semidrying (setting) oil is blown (preoxidised) linseed oil or wood oil.
10. Shaped body according to any one of the preceding claims, characterised in that the impregnating agent furthermore contains at least one of the following substances: waxes, lignin, higher alcohols; hardened or modified, animal and vegetable fats; wool fat, tallow; salts of different fatty acids, flame retardants - the latter optionally with the addition of small amounts of a solubiliser.
11. Shaped body according to claim 10, characterised in that the waxes are Carnauba wax, bees' wax, montan wax.
12. Shaped body according to claim 10, characterised in that the hardened or modified, animal and vegetable fats are hydrogenated vegetable fats and epoxidised oils.
13. Shaped body according to claim 10, characterised in that the salts of different fatty acids are salts of stearic acid, behenic acid, lauric acid.
14. Shaped body according to claim 10, characterised in that the solubiliser is glycerol.
15. Shaped body according to any one of the preceding claims, characterised in that the impregnating composition consists of
 - 10- about 60% by weight of natural resin;





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- 10-40% by weight of wax;
- 10-50% by weight of drying oil;
- 0.25-20% by weight of drying agent; and
- 10-30% by weight of a biodegradable polymer.

5 16. Shaped body according to claim 15, characterised in that the impregnating composition contains 15-35% by weight of wax.

17. Shaped body according to claim 15, characterised in that the impregnating composition contains 20-40% by weight of drying oil.

18. Shaped body according to claim 15, characterised in that the drying agent is cobalt, zinc 10 and manganese resins, octanoates, linoleates and naphthenates.

19. Shaped body according to claim 15, characterised in that the impregnating composition contains 15-25% by weight of a biodegradable polymer.

20. Shaped body comprising impregnated solid wood, substantially as hereinbefore described with reference to any one of the examples but excluding the comparative examples.

15 21. Process for the production of a shaped body according to any one of the preceding claims, characterised in that the wood part is immersed in the melt formed from the impregnating composition and is left under pressure and temperature for 10-120 minutes, and is then removed from the melt, optionally freed superficially from said melt and finally cooled.

22. Process according to claim 21, characterised in that the wood part is preheated to a 20 temperature of 100-150°C.

23. Process according to claim 21, characterised in that the wood part is left under pressure and temperature for 30-90 minutes.

24. Process according to any one of the preceding claims, characterised in that the melt with the wood part is placed under vacuum and/or is then brought to a super atmospheric pressure of 1- 25 100.

25. Process according to claim 24, characterised in that the melt with the wood part is brought to a super atmospheric pressure of 2-20bar.

26. Process for the production of a shaped body, substantially as hereinbefore described with reference to any one of the examples but excluding the comparative examples.

30 27. The use of a shaped body according to any of claims 1 to 20 for the production of solid wood parts which can be moulded by a thermoplastic method.

Dated 21 September 1998

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